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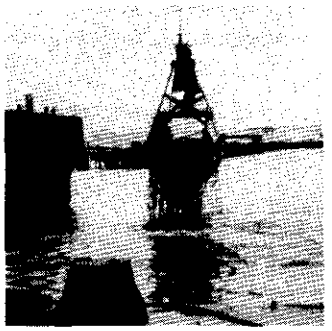

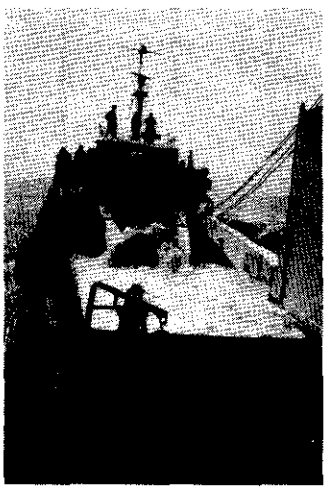

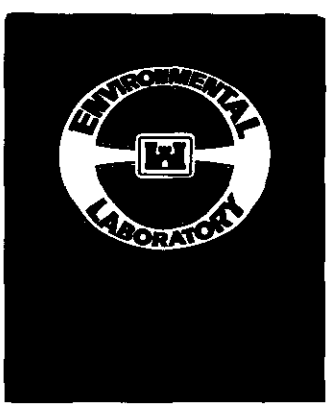

Environmental Effects of Dredging

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Tagging loggerhead sea turtle on the deck of a shrimp trawler

Entrainment of Sea Turtles by Hopper Dredges in Cape Canaveral and King's Bay Ship Channels

Dena D. Dickerson
US Army Engineer Waterways Experiment Station

James I. Richardson, Joseph S. Ferris, Anna L. Bass
Institute of Ecology, University of Georgia

Mark Wolff
US Army Engineer District, Jacksonville

This article summarizes information on reported incidents with sea turtles during dredging in the Canaveral and King's Bay ship channels from 1980 to 1990. Gaps in the present monitoring records for making quantitative assessments of entrainment effects are also addressed.

The ship channels at Cape Canaveral, FL, and King's Bay, GA, allow navigation from offshore through constructed inlets

to protected harbors (Figures 1 and 2). Both channels have been widened and deepened several times to accommodate larger commercial shipping and the development of Navy Trident submarine bases. Hopper dredges have been used for most dredging operations in both channels.

As with other maintenance dredging operations in navigational channels throughout the southeastern United States, these dredging projects are required to comply with the Endangered Species Act (ESA) of 1973. The major concern is entrainment of sea turtles by hopper dragheads. Five species of sea turtles occur along this coastline and are listed as threatened or endangered. The loggerhead sea turtle (*Caretta caretta*) is listed as threatened, while the green sea turtle (*Chelonia mydas*), the Kemp's ridley (*Lepidochelys kempi*), the hawksbill (*Eretmochelys imbricata*), and the leatherback (*Dermochelys coriacea*) are all less abundant and listed as endangered. Of primary concern is the Kemp's ridley, which is considered to be the most critically endangered of the sea turtles worldwide. The National Marine Fisheries Service (NMFS) has determined that because of their life cycle and behavioral patterns only the loggerhead, the green, and the Kemp's ridley are put at risk by maintenance dredging activities (Studt 1987). Surveys and radio tracking studies indicate that these turtles are attracted to and seek refuge at Cape Canaveral entrance channel, especially during the winter (Butler, Nelson, and Henwood 1987). The NMFS designated the fall months as the best time for hopper dredging based on the turtles' winter seasonality trends and the presence of gravid females during the summer nesting season.

Periodic maintenance dredging of Canaveral harbor and portions of the channel has been performed since 1953 (Studt 1987). Major construction associated with the development of the Trident submarine base began in 1976. Shortly thereafter, shrimpers began reporting increased captures of sea turtles. During two unusually cold winters prior to the scheduled 1980 maintenance dredging, the presence of large numbers of loggerhead sea turtles in the channel was brought to the attention of the scientific community by shrimpers who had incidentally trawled-up a number of turtles in a lethargic condition. Sea turtle mortalities were documented during the 1980 dredging activities; however, no documented mortalities were attributable to dredging before 1980.

In the past 10 years, little success has been made in identifying practicable methods for locating turtles

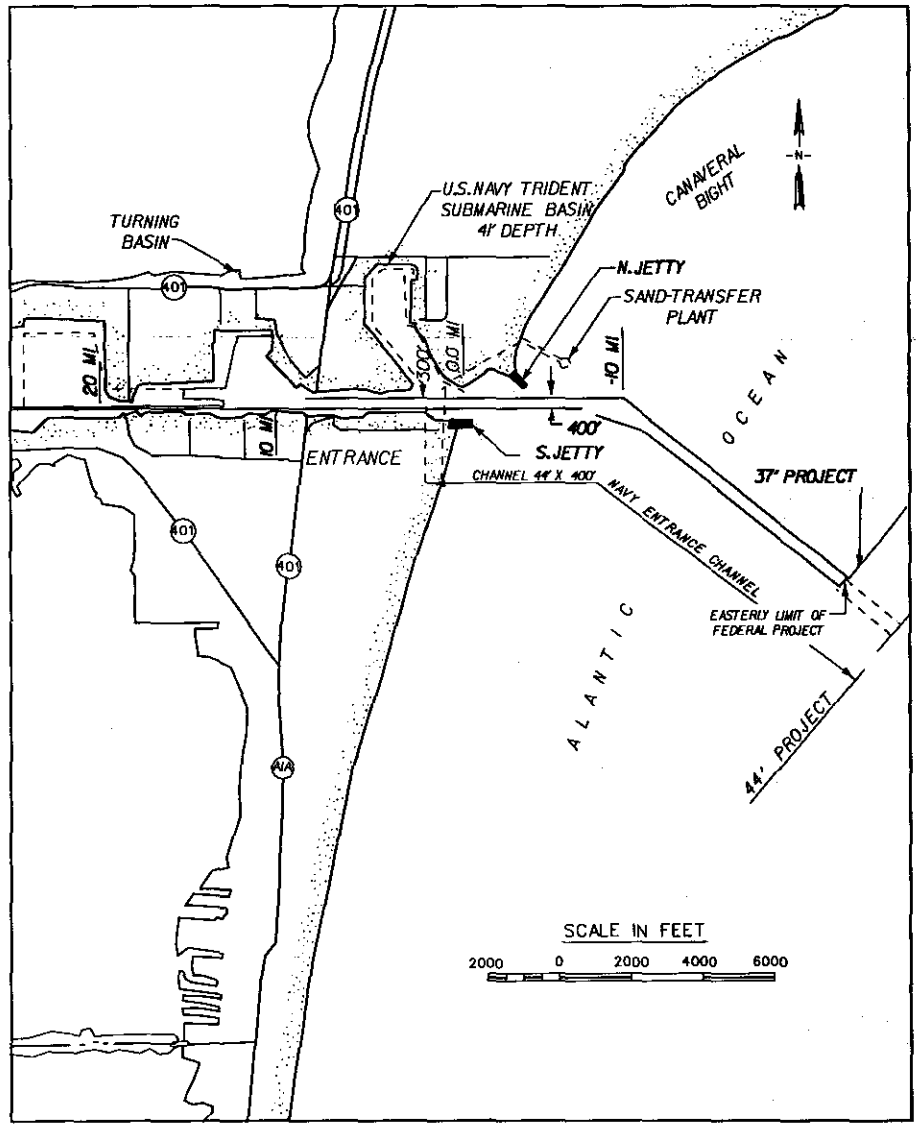


Figure 1. Cape Canaveral, FL

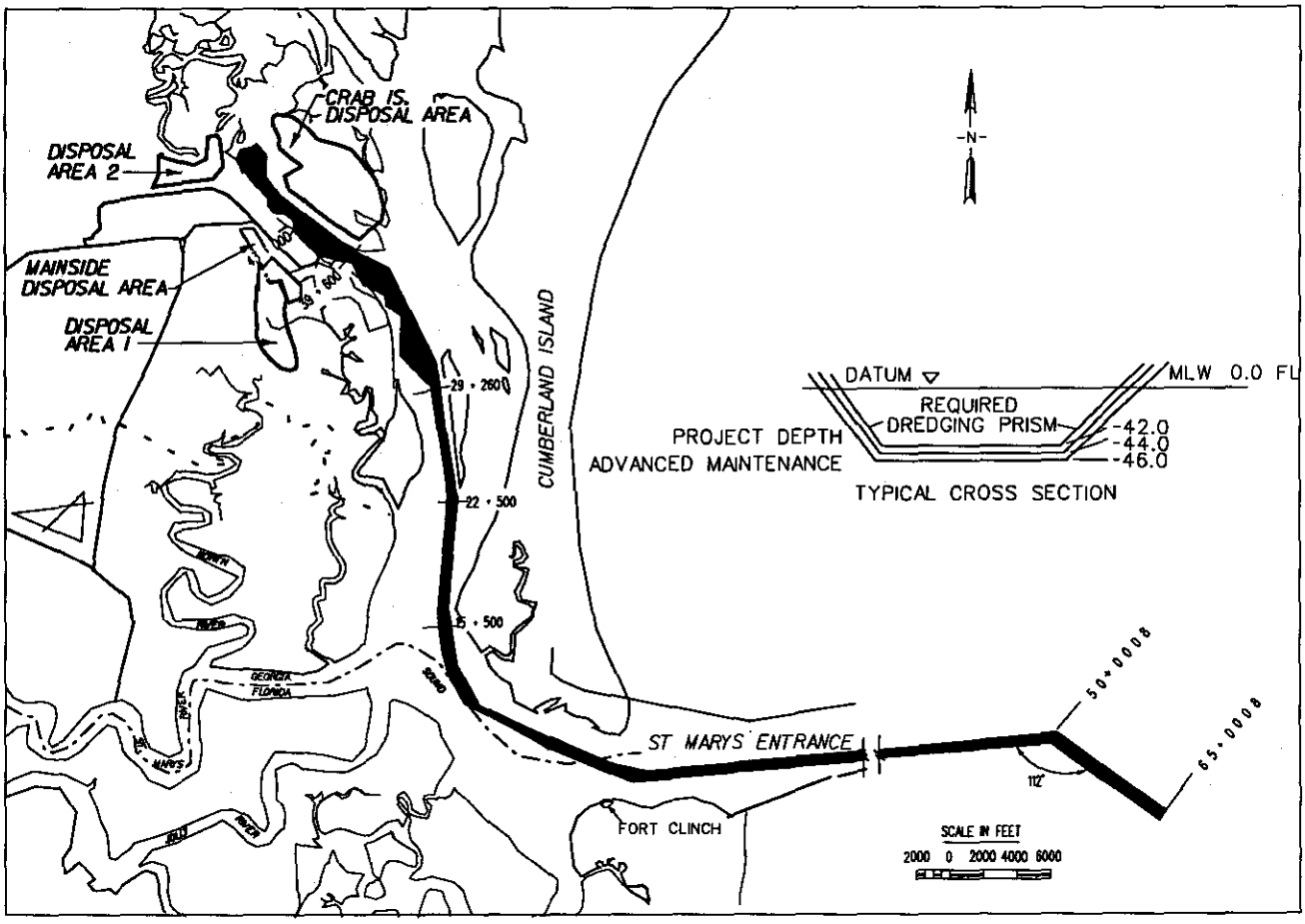
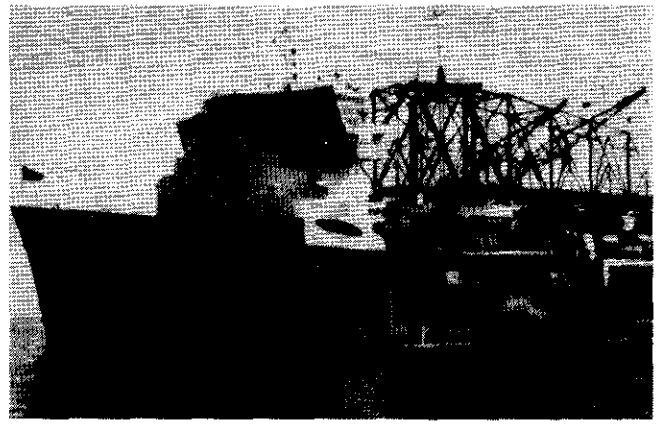


Figure 2. St. Marys Entrance ship channel, King's Bay, GA

in the path of the hopper dredge. Measures investigated include Fathometers and side-scan sonar to identify turtles in the water column or sediment. Methods to deter turtles have also been tested such as sonic pingers and bubble screens. These methods have had limited effectiveness in keeping sea turtles away from the path of the draghead. Turtles have even been captured and relocated out of the channel and dredging area using trawling procedures.

The most significant operational change used to avoid turtle mortalities may have been changing the type of draghead used on the hopper dredge. During the Canaveral maintenance dredging in 1980, an IHC draghead was used. Subsequent dredging used the California-style draghead. Studt (1987) presented evidence that the design and upright positioning of the IHC draghead causes its suction opening to act like a scoop, while the California-style draghead sits level in the sediment and may be less likely to entrain turtles.

Methods to physically move the turtles away from the draghead have also been tested. The Corps tested a "cow-catcher" turtle deflector in 1981 on the Corps' dredge *McFarland*. This deflector, under these environmental conditions, was damaged, which prevented it from reducing turtle mortalities. Two additional conceptual designs for turtle deflectors were tested during the 1988 maintenance dredging of Canaveral. Although a rigid deflector design was not as effective after three days of dredging due to structural damage,



Corps of Engineers hopper dredge *McFarland*

a flexible chain deflector design maintained its structural integrity throughout the dredging project. Modified flexible chain turtle deflectors were also installed on both dragarms of the *McFarland* for tests during the entire 1989-1990 maintenance dredging at Canaveral.

An additional operational procedure was implemented in 1985 involving turning off the dredge pumps when the dragarms are raised and lowered. This was to reduce the potential of entraining turtles swimming around the dragheads. However, it is impossible to stop the pumps completely before lifting the dragheads from the bottom sediments. To do so risks packing the dragarms, pumps and delivery lines with sediment, requiring costly downtime to clear them. The dragtender must lift the dragheads off the bottom and continue pump operation until clear water is flushed through the lines into the hopper. Then the pumps can be throttled back or stopped and the arms can be lifted through the water column.

Female loggerhead sea turtle returning to the water after nesting

Methods

The Endangered Species Observer Program was established in 1980 and evolved through consultation between the NMFS and the US Army Corps of Engineers (USACE), in accordance with the Endangered Species Act. The observers work closely with the dredge crew to identify and record dredging incidents with sea turtles and other endangered species. Sampling for turtles and parts is done through observation and inspection of the hopper along with screening of the intake structures or hopper overflow. Information on reported incidents is documented in unpublished USACE reports, observer reports and log sheets, and ship's records. These are scattered throughout various Corps and NMFS offices. Files at the US Army Engineer District, Jacksonville office, the US Army Engineer Waterways Experiment Station, the St. Petersburg office of the NMFS, the Georgia Sea Turtle Cooperative at the University of Georgia as well as conversations with various researchers, relevant records, reports, and correspondence were reviewed and analyzed.

Loggerhead sea turtle

A summary was prepared for each reported sea turtle incident which contained only cases directly attributable to dredging activities and excluded reports on old turtle bones and decaying tissues. Documented turtle mortalities are those in which the animal or body parts surfaced in the hopper or were large enough to be caught on screens and structural components and subsequently reported by observers or the ship's crew.

Results

Table 1 summarizes dredging activity and sea turtle incidents in the Cape Canaveral and King's Bay channels. Compilation of the incident records is complete except for data from the ships' logs and incidental information such as water temperatures during the dredging periods. These missing data limit complete analysis of the records.

The relationship between sea turtle incidents and vessel locations in the channels was examined from the ships' logs, observer data sets, and project summary reports. Trawling surveys for the Canaveral channel have shown a definite seasonality in abundance and dominance of various groups of loggerheads, that is, adult males, adult females, and subadults, during the year.* Figure 3 shows the monthly distribution of reported incidents for both channels. The increase of reported incidents from July through December reflects the predominance of dredging activity during the dredging window defined by the NMFS. NMFS established this dredging window based on historical biological and trawling data.

The incidental take of sea turtle species during dredging operations has been documented in the Canaveral ship channel since the first study conducted in 1980.** During the eleven-year dredging period from 1980 to 1991, 178 incidents with three species of sea turtle (loggerhead, green, and Kemp's ridley) have been reported from Cape Canaveral and King's Bay entrance channels (Table 2). This included 147 incidents at Canaveral and 31 incidents in King's Bay channel. Reported incidents have been limited to hopper dredges. Observer records document the intake of turtles or parts of turtles through the vessel's dragheads and subsequently into the ship's hopper. Eighty-nine percent of the turtles entrained by the dragheads have died.

The species distributions of reported turtle entrainments for King's Bay and Cape Canaveral are summarized in Table 2. The majority of identified entrained turtles (n = 126) were loggerheads (78 percent), with green turtles accounting for 20 percent of those identified, and ridleys 2 percent. Unidentified turtles (n = 52) accounted for 29 percent of total incidents reported and were identified as turtles by portions of the body or internal viscera. Biochemical and genetic techniques are now available for identification of tissues to species.†

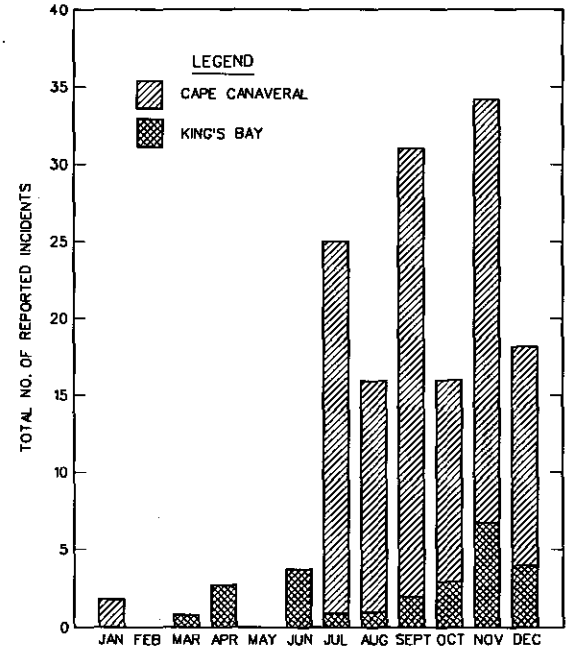


Figure 3. Monthly distribution of reported sea turtle entrainment incidents for King's Bay and Cape Canaveral (1980-90)

Comparison of the numbers or species taken and the time of capture shows no clear trend. This comparison is based on the time of day or night the reported incident occurred in relation to the dredging activity. This assessment shows 42 percent of the documented incidents occurred during the daytime, 33 percent at night, and for 24 percent the time was not recorded. Additional data from ships' logs may assist in categorizing the unidentified incidents and allow for future comparison.

* A. Bolton and K. Bjorndal. 1988. "Survey of Sea Turtles in Cape Canaveral Channel," Unpublished 1988 survey reports to National Marine Fisheries Service, St. Petersburg, FL.

** P. W. Raymond. 1980. "Marine Turtle Observations aboard Dredge *Long Island*, Port Canaveral, Florida, 19 July - 1 August 1980," Unpublished report to National Marine Fisheries Service, St. Petersburg, FL.

† B. Bowen, W. Nelson, and J. C. Avis. 1990. "Identification of a Marine Turtle Tissue Sample," Unpublished report to US Army Engineer District, Jacksonville, and Institute of Ecology, University of Georgia, Athens.

Table 1

Sea Turtle Entrainment from Hopper Dredges for Cape Canaveral and King's Bay Channels, 1980 - 1991

Date	Amount Dredged cubic yards	Protection/Monitoring Measures Implemented	Vessels	Total Number of Turtle Incidents
Canaveral				
1980 7/11 - 8/8 8/26 - 11/13 11/12 - 11/30	1,400,000	100% observer monitoring; trawling/relocation*	*Long Island* *Dodge Island* *Sugar Island*	71
1981 8/13 - 9/22	257,400	100% observer monitoring; overflow screening; draghead deflector	*McFarland*	6
1983 2/? - 5/?	609,000 (Inside jetties)	100% observer monitoring; overflow screening	*McFarland* and *Sugar Island*	NA**
8/? - 12/?	914,000 (Seaward of dog leg)	100% observer monitoring; overflow screening	*McFarland*	NA
1984 12/8 - 12/30 11/26 - 12/18	2,700,000	California draghead; 25-50% observer monitoring; overflow screening	*Sugar Island* *McFarland*	12
1985 1/15 - 1/31	370,000	California draghead; 50-100% observer monitoring; overflow screening; pump shut-off at lift	*McFarland*	0
1986 9/2 - 10/6	350,000	California draghead; 75-100% observer monitoring; overflow screening; pump shut-off at lift	*Ouachita*	5
1988 8/24 - 10/19 8/29 - 9/4 8/29 - 10/21	1,408,000	California draghead; 100% observer monitoring; overflow screening; inflow screening (not on *Dodge Island*); draghead deflectors; trawling/relocation*	*Dodge Island* *Atchafalaya* *Mermentau*	34
1989/1990 12/6 - 1/16	290,000	California draghead; 100% observer monitoring; inflow screening; draghead deflectors; trawling/relocation*	*McFarland*	11

* Trawling/relocation of turtles only used during later half of dredging project.

** Data not available.

(Continued)

Table 1 (Concluded)

Date	Amount Dredged cubic yards	Protection/Monitoring Measures Implemented	Vessels	Total Number of Turtle Incidents
Canaveral (Concluded)				
1990/1991 12/14 - 1/21	212,848	California draghead; 100% observer monitoring; overflow screening; draghead deflectors; trawling/relocation*	*Sugar Island*	8
King's Bay				
1986 5/?	250,000	(Found by dredge crew)	*Sugar Island*	1
1987 7/15 - 12/31	910,000	California draghead; 100% observer monitoring; overflow screening	*Manhattan Isl.* *Jim Bean* *Sugar Island* *Eagle I*	5
1988 1/1 - 7/24 10/31 - 12/9	5,456,000	California draghead; 100% observer monitoring; overflow screening	*Eagle I* *Manhattan Island* *Mermentau* *Atchafalaya* *Ouachita* *Sugar Island* *Dodge Island*	11
1989 5/31 - 6/11	152,000	California draghead; 100% observer monitoring; inflow screening	*McFarland*	3
11/11 - 12/18	720,000	California draghead; 100% observer monitoring; overflow screening	*Atlantic American*	6
1990 10/21 - 12/13	754,000	California draghead; 100% observer monitoring; overflow screening; draghead deflector	*Sugar Island*	4
1991 1/24 - 3/23	766,685	California draghead; 100% observer monitoring; overflow screening; draghead deflector	*Sugar Island*	1

Table 2

Reported Sea Turtle Entrainment Incidents by Species During Dredging Activities, 1980 - 1991

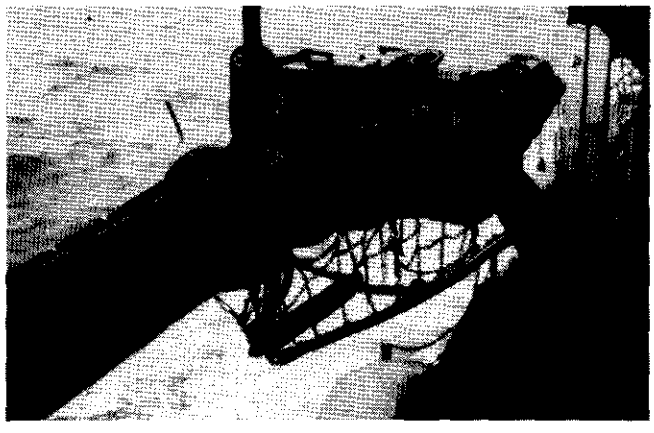
Year	*C. Caretta*		*L. kempi*		*C. mydas*		Unidentified*	Total	
	Dead	Live/ Injured	Dead	Live/ Injured	Dead	Live/ Injured		Dead	Live/ Injured
Cape Canaveral Entrance Channel, Florida									
1980	50	--	--	--	--	3	18	68	3
1981	3	--	--	--	--	1	2	5	1
1984/85	1	--	--	--	--	--	11	12	--
1986	3	2	--	--	--	--	--	3	2
1988	12	1	--	--	2	1	18	32	2
1989/90	--	--	--	--	6	3	2	8	3
1990/91	2	1	--	--	2	3	0	4	4
Totals	71	4	0	0	10	11	51	128	19
Kings' Bay Entrance Channel, Georgia									
1986	1	--	--	--	--	--	--	1	--
1987**	3	--	--	--	1	--	1	5	--
1988	6	--	3	--	1	1	--	10	1
1989	8	--	--	--	1	--	--	9	--
1990	4	--	--	--	--	--	--	4	--
1991	1	--	--	--	--	--	--	1	--
Totals	23	--	3	--	3	1	1	30	1

* Fragments of sea turtle carcasses not identified to species. It is assumed that most are *Caretta caretta*.
** Initial construction dredging for Trident submarine base.

Discussion

A significant problem in the interpretation and analysis of these records is the variation in sampling efficiency for each dredging period.

The method of screening, percent material screened, and the mesh size of the screens varied with the project and vessel. Problems have resulted from the use of dredged material overflow screening of the hopper. Insufficient upwelling of materials within the hopper will apparently not force large remains of turtles to the screens (Berry 1990). The most effective method of retrieving turtle parts was screening of the intake structures in the hopper. Although not feasible on all vessels, this was done on the *McFarland* during the 1989 and 1990 dredging projects in the Canaveral ship channel. During the 6 December 1989 through 16 January 1990 Canaveral dredging project, the intake screening was estimated to have effectively screened 60 percent of the material entering the vessel. With this approach the observers did not have to rely on seeing turtles or their parts floating in the hopper or entrained on an overflow screen. Using this method, the observers were able to document six juvenile green turtles entering the hopper that may otherwise have been missed.



Sea turtle deflector attached to the draghead

A second factor that may have introduced bias into the data was variation in the openings under the dragheads. Dragheads with smaller opening size may, in fact, have resulted in a number of turtles being

crushed beneath the draghead and never observed. How many and what percentage died is unknown. The average sizes of carapace length reported for entrained turtles (loggerhead, <76 cm; green, <45 cm; and ridley, <37 cm) represent subadults. Several loggerhead skulls recovered from the hopper, however, had widths greater than 15 cm, which represent adult turtles. These observations and observer records indicate that the larger turtles impinged beneath the draghead either died intact and were not entrained or were torn apart and portions of the turtle drawn into the hopper.

Another serious problem is the inability to correlate information on entrainment with the time of day, environmental conditions, or location in the channel since it is not possible with the present records to know exactly when the turtle was caught. Interpretation of these kinds of data is very limited given these problems. Monitoring methodology, data collection, and record keeping are being modified to alleviate some of these problems and provide better analysis of the data in the future.

Summary

Observers have reported that hopper dredging activities in Cape Canaveral and King's Bay ship channels have resulted in mortalities to loggerhead, green, and Kemp's ridley sea turtles. No clear trends have emerged from existing records because of varying sampling methods and existing gaps in the present records. Problems with record keeping and reporting are being addressed, and recommendations for data collection and observer activities will be provided in the future.

Numerous methods have been employed to reduce or prevent sea turtle mortalities from dredging operations. A reduction in sea turtle mortalities during dredging in the Cape Canaveral ship channel since 1980 may be attributed to operational changes and possibly to a decrease in the local abundance of turtles.

Measures to protect sea turtles have evolved and improved during maintenance dredging since 1980, but mortality has not been eliminated. Equipment designs will continue to be tested as well as alternative methods to reduce the number of sea turtle mortalities resulting from dredging. The Corps of Engineers continues to work with the National Marine Fisheries Service to minimize entrainment of sea turtles while continuing to perform needed maintenance dredging of navigation channels. Through cooperative efforts, dredging impacts to sea turtles will be minimized in the future.

For additional information, contact Dena Dickerson at (601) 634-3816.

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This issue reports on sea turtle entrainment problems encountered during dredging operations in Cape Canaveral, Florida, and Kings Bay, Georgia, ship channels. Numbers and species of turtles entrained over time are presented for three endangered or threatened sea turtle species. Further discussions describe the success of various methods used to reduce turtle mortalities resulting from dredging.

ENVIRONMENTAL EFFECTS OF DREDGING

This bulletin is published in accordance with AR 25-30 as an information dissemination function of the Environmental Laboratory of the Waterways Experiment Station. The publication is part of the technology transfer mission of the Dredging Operations Technical Support (DOTS) Program managed by the Environmental Effects of Dredging Programs. Results from ongoing research programs will be presented. Special emphasis will be placed on articles relating to application of research results or technology to specific project needs. Contributions of pertinent information are solicited from all sources and will be considered for publication. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or the approval of the use of such commercial products. Communciations are welcomed and should be addressed to the Environmental Laboratory, ATTN: Dr. Robert M. Engler, U.S. Army Engineer Waterways Experiment Station (CEWES-EP-D), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, or call AC 601/634-3624.

LARRY B. FULTON
Colonel, Corps of Engineers
Commander and Director